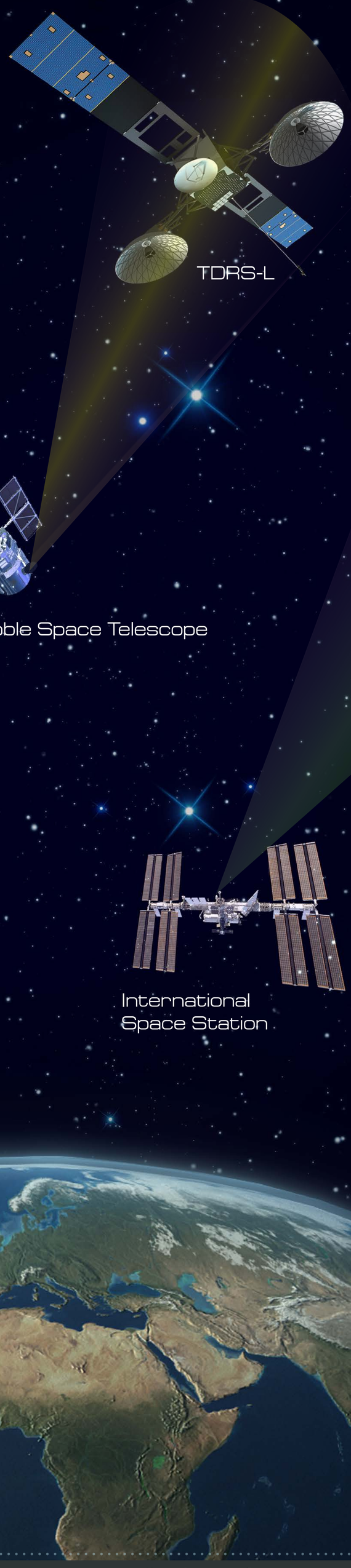
National Aeronautics and Space Administration

TDRS

RELIABLE COMMUNICATIONS FOR MISSION SUCCESS




Hubble Space Telescope


Terra

International Space Station


First Generation TDRS


Guam

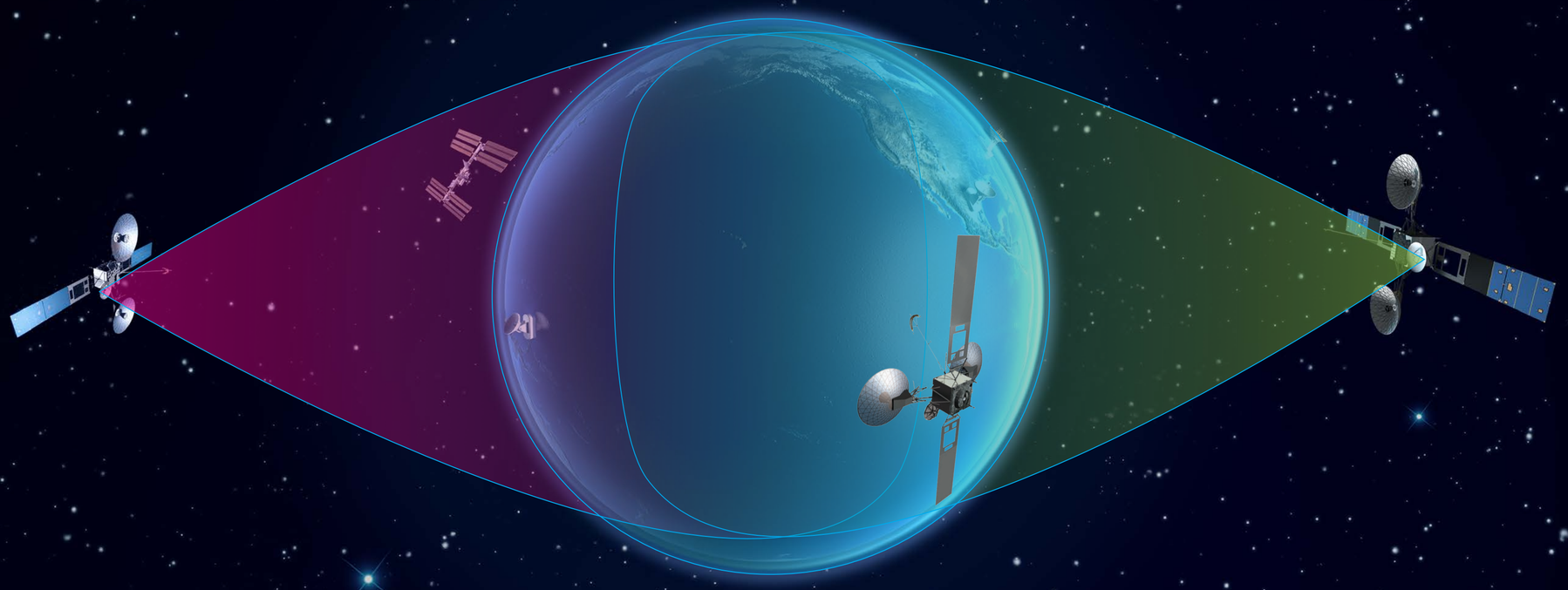
The Tracking and Data Relay Satellites (TDRS) create a constellation of geosynchronous communication spacecraft that provide continuous global data relay services between Earth-orbiting satellites and their data processing facilities on the ground. In a general sense, TDRS acts as a space-based internet router, ensuring that commands and data from dozens of satellites are delivered on time, every time.

This illustration of the TDRS Network shows how the TDRS spacecraft communicate with user satellites, such as the Hubble Space Telescope, the International Space Station, and the Earth observing satellite, Terra, to name a few. The TDRS constellation provides nearly continuous communication between these satellites and their users.

THE TDRS GROUND SEGMENT

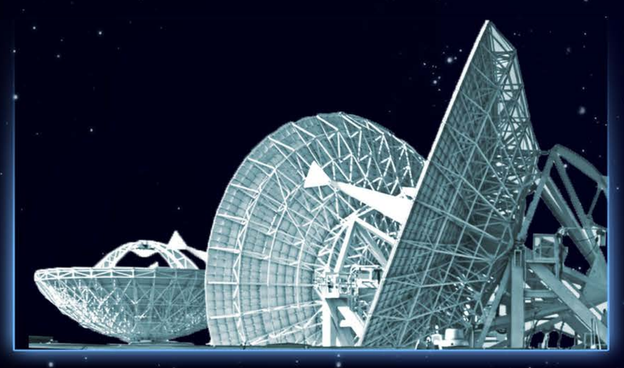
There are always at least three operational Tracking and Data Relay Satellites (TDRS) relaying data between Earth-orbiting satellites and the TDRS ground segment. Each TDRS is placed in one of three locations around the globe and travel in geo-synchronous orbit, allowing them to maintain 100% global communication coverage. In addition, there are multiple on-orbit spare satellites that stand ready to be brought into operational use on a moment's notice.

The space-based TDRS relay commands and data between satellites and ground terminals on Earth. Housing engineers and operators maintain the ground terminals, where the overall command and control services take place. TDRS ground terminals are located at three principal facilities, and together, they form the terrestrial portion of NASA's Space Network (the other half being the TDRS spacecraft).



This illustration of the Space Network shows how the TDRS relay between Earth orbiting satellites and the ground terminals. Ground terminals in White Sands, NM and Guam are capable of providing continuous communications between the user spacecraft, such as the International Space Station, and its ground facilities. TDRS provides nearly continuous communication between these satellites and their users.

The TDRS ground segment consists of:



The White Sands Ground Terminal (WSGT) located near White Sands, New Mexico. WSGT came online in 1978.

The Second TDRSS Ground Terminal (STGT) located near White Sands, New Mexico. STGT came online in 1994.

The Guam Remote Ground Terminal (GRGT) located near Dededo, Guam. GRGT came online in 1992.

Three highly automated ground terminals provide a constant connection between the TDRS constellation and the User's processing facilities. Two of them are located at the White Sands Complex (WSC), and one is in Guam. WSGT went online just in time for the Space Shuttle's debut in early 1979. GRGT replaced an earlier ground facility in Diego Garcia and continued coverage for TDRS that cannot be seen from the continental US. STGT was built to help handle the large amount of data that WSGT was receiving.

• HOW IS THE LOCATION FOR A GROUND STATION SELECTED?

The most important consideration when choosing a ground terminal location is the visibility of the TDRS's orbit arc from the ground. This depends on the longitude of the specific TDRS. Because TDRS spacecraft are distributed around the world at various longitudes, a single ground station would not be able to communicate with the entire constellation. Since TDRS are placed in geosynchronous orbit, the ground station location should have an unobstructed view of the orbit arc so that the antenna can keep the satellite in sight. With geosynchronous orbit above Earth's equator, the best locations for TDRS ground terminals are relatively lower latitudes. Between the one terminal in Guam and the two in White Sands, New Mexico, all orbiting TDRS are in sight.

Another key element in selecting the ground station's location is weather. It turns out that high frequency radio waves can be absorbed by rain drops (think about your satellite TV reception during a rainstorm). Arid environments, such as New Mexico's desert, don't have a lot of rain. In fact, the New Mexico desert averages 350 days of sunshine per year!

HOW DO THE GROUND TERMINALS COMMUNICATE WITH SATELLITES IN SPACE?

The ground terminals use large antennas, called Space-Ground Link (SGL) antennas to transmit and receive radio frequency energy. These antennas are custom made, with precisely shaped parabolas that gather the most energy possible from TDRS. The ground terminal engineers perform a complex series of steps to command the SGL antennas to point at the TDRS. These engineers are also responsible for controlling all of the ground terminal's equipment, which includes computers, amplifiers, switches, frequency converters, and many other components to establish and maintain the TDRS communications link. The Network Control Center Data System (NCCDS), located in New Mexico, is the portal through which users schedule and monitor the status of their TDRS services. The NCCDS also helps to isolate problems when they occur by coordinating resources around the globe.

The three highly automated ground terminals receive commands from the user's data facilities and then beam them up to the user's spacecraft, such as "Hey satellite, turn your camera on!" At the same time, these ground terminals are receiving user spacecraft data (like images collected from the Hubble Space Telescope) from the TDRS constellation and transferring the data to the scientists and engineers on the ground.

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